Tecnews

A publication for the presentation of new ideas . . . new methods . . . new products . . . in the associated fields of radio and electronics.

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140 11th ST. OAKLAND 7, CALIF.

SOME COMMENTS ON VACUUM CAPACITORS AND SWITCHES.

By Clayton F. Bane, W6WB.

Moveable mechanical elements sealed in an evacuated container yet capable of precise external control...here is something that not too many years ago, would have brought forth the classic misstatement, "It just can't be done." We refer of course to the series of devices, vacuum variable capacitors and switches whose operation depends upon mechanical linkages to evacuated elements. Many of the actual operational details have not been given much publicity in amateur literature therefore the cursory treatment to follow may be pertinent.

Let it be stated at the outset that no air-tight gasket trickery is involved...the interior fixed and moveable parts are firmly and permanently sealed to the glass enclosure. How then can one externally control the movement of a completely sealed in mechanical element? A clever little gimmick, the metal bellows, provides the answer.

Jo Jennings, (good amateur that he is) has been kind enough to provide us with a simplified cross-sectional drawing showing exactly how the metallic bellows is applied in the Jennings vacuum capacitors. Bear in mind that these metallic bellows are fabricated from thin metal...that they have one closed end...that they are normally compressed... that they may open out accordion-fashion. In actual practice the outer edges of the open end of the bellows is sealed to an opening in the glass envelope, (along with certain internal bearing elements) and the envelope evacuated and sealed-off. This process leaves the interior of the closed-end bellows exposed to outer atmosphere. It is now possible to cause the bellows to extend by applying suitable pressure to the closed-end. As a matter of practical fact, a pressure differential exists between inside and outside...there being no air in the container. Normal atmospheric pressure at sea level amounts to 14.7 pounds per square inch so that, (assuming surface area somewhat greater than one square inch) a force approximating 20 pounds per square inch is exerted. This is sufficient to fully extend a bellows of average thickness. In a vacuum switch this pressure may be intentionally cancelled by use of a suitable spring since it is here desirable to move the contact inward for "Make" purposes. Inward pressure is utilized to advantage in vacuum variables since the bellows movement is precisely controlled by a lead screw and nut. In this instance, the ever-present inward pressure causes the lead screw threads to bear always against one face of the equivalent threads in the lead nut. Backlash, or inability to return exactly to a previous setting, is therefore eliminated.

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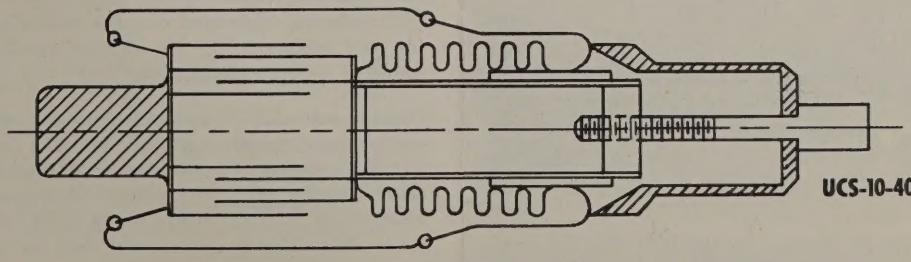


SIMPLIFIED CROSS-SECTION DRAWING SHOWING BELLOWS AND LEAD-SCREW DETAILS.

(Continued from front page)

Perhaps we make all this sound so simple that some may wonder why, if its so easy, these items are not cheaper in price. I wondered myself and looked into the matter, toured the Jennings plant.

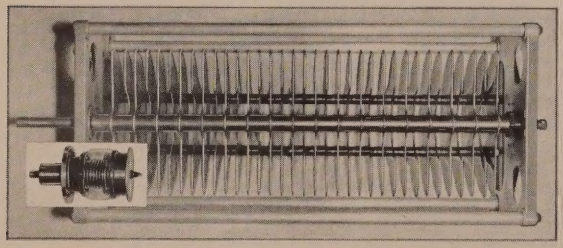
It turns out that vacuum capacitors are an ultra-precision product, every element and assembly procedure being subjected to stop-and-go checks in so many assembly steps that I personally lost count. Those little concentric tubular members which make up the fixed and moveable capacitor elements are machine-aligned to tolerances less than .001"

The main bearing which shows in the accompanying drawing as a simple series of parallel lines, is actually one of highest precision, is subjected to many temperature cyclings prior to acceptance for final installation. It is not difficult to imagine the many undesirable effects which can result from the use of poorly fitted capacitor bearings.

One cannot take metal parts directly from the shop and proceed to seal them into the glass container. All interior metallic parts must be clean... completely and chemically clean, free from oxides and other foreign substances. Capacitors which may have picked up contaminants on their way to final test never get past the first preliminary test.

"Pulling a vacuum" on the container is, in itself, a pains-taking, time consuming process since the required vacuum must necessarily be of the highest order. All in all, manufacturing one of these capacitors is no job for the home workshop.

The advantages of vacuum variable capacitors from the standpoint of size are obvious. Just compare the well-made conventional variable with the tiny vacuum variable on its left...keeping in mind that both have the same operating voltage ratings.



Perhaps not so obvious is the fact that the basic construction of a vacuum capacitor is such that low internal inductance is inherent. The high voltage ratings of most vacuum variables permits direct connection to ground without danger of D.C. flashover. This in turn, automatically provides a short, direct path to ground for harmonics. The small surface area presented by the capacity body minimizes direct harmonic radiation. It is also interesting to note that these capacitors have RF resistance values which may be substantially lower than air variables with equivalent capacity and operating voltages. This is due to large surface area of high conductivity, to the elimination of multiple spacers, and to the absence of metallic oxides with poor conductivity. So, to some closing considerations on voltage and current ratings.

The current ratings of these vacuum variables are predicated upon the amount of heat rise the particular capacitor will safely withstand. Part of this heat will be due to normal losses produced by RF current flowing through the capacitor. Heat will be inevitable since even the best metallic conductors have some resistance. The UCS capacitor for example, is factory tested to establish the 65 ampere rating on the highly consersative basis of a 75°C rise above ambient temperature. For amateur service where the duty cycle never approaches that of continuous commercial service, a 100 ampere rating may be considered safe. Due consideration should also be given to the probability that the ultimate operating temperature may not be due solely to I^2R capacitor losses. Heat may, and normally does, rise in the capacitor as the result of direct conduction. For example, heat generated in the associated vacuum tubes may be conducted to the capacitor through conducting leads or strips. (Both generally having substantial surface areas.) Overall temperature rise in small, poorly ventilated enclosures will obviously contribute to the heat rise in the capacitor. Don't get too nervous though...it will require a very high C circuit to produce the 100 amperes mentioned and the associated inductor will probably fold up well in advance of this point of maximum heat rise.

Theres not much to be said about exceeding voltage ratings, surely nothing that will interest the average amateur. I know that 10,000 volts is somewhat beyond my own modest requirements. The operator of a KW(?) phone might have to give consideration to the possibility that an occasional modulation peak may exceed the capacitor voltage rating. To him, (if there be such) a comforting word...variables of the UCS' type are self-healing after momentary internal flashover.

AN EXCEPTIONAL BARGAIN

A BEAUTIFUL, BRAND-NEW
FULLY GUARANTEED, 10,000 VOLT

UCS-10-400X

VACUUM VARIABLE CAPACITOR

AT

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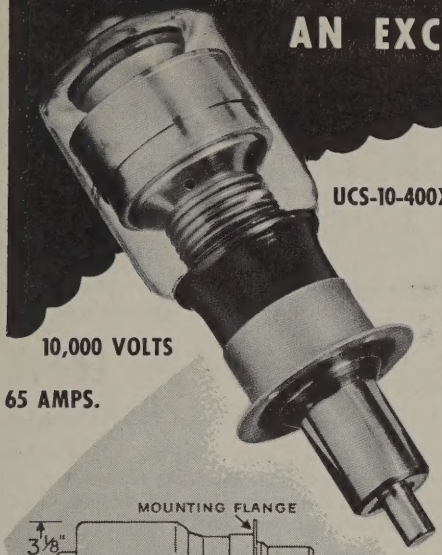
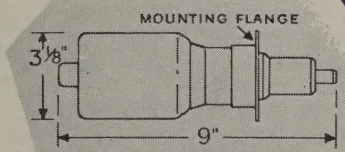


10,000 VOLTS

65 AMPS.



SPECIFICATIONS

CAPACITY: 10 mmf min. 400 mmf max.
VOLTAGE RATING: 10,000 volts. . . .
CURRENT RATING: 45 amperes, RMS. .
DRIVE: Low backlash leadscrew, 25 turns for complete capacity range.

APPLICATIONS

(1)—FINAL TANK CAPACITOR:
for single-ended stages of all types. Particularly effective where HV is used on 100% AM stage. Mounting permits direct, low inductance, stator-to-chassis RF path . . . . . .

"C" adequate for any stage, linears included, on low frequency bands yet very low minimum permits operation on higher frequency bands with low "C". . . .

High capacity ratio, (40:1) opens up real possibilities for multi-band operation . . . . . .

Two UCS-10-400 may be ganged readily by gearing for balanced P-P operation.

(2)—PI NETWORKS:
Ideal as tunable input or output capacitors for pi networks particularly where high RF currents are involved. Eliminates expensive, switched micas. Maximum capacity adequate for most high powered tetrode stages working into 52 ohms, even at 80 meters. (See QST 1954, May P 13, Aug. P 30). . . . . .

As advertised in QST

This is the first time that a capacitor of this type has been offered at other than full price. These capacitors are not war surplus items. A limited quantity was produced for a leading electronic manufacturer, every unit being required to meet exacting inspection tests. The capacitors were manufactured by Jennings Radio Manufacturing Corp., internationally recognized as the foremost producers of vacuum variables of highest quality.

Elmar Electronics was fortunate in obtaining this desirable merchandise as the result of contract cancellation and is making it available at an exceptionally low price. Every capacitor is fully guaranteed, each is new, in perfect condition.

How else can you hope to duplicate . . . or even approach . . . performance characteristics like these? An air variable with 10 to 400 mmf capacity ratio and 10 kv breakdown would probably exceed two feet in length. Both fixed and movable elements in this UCS capacitor are sealed in an evacuated glass envelope, motion within vacuum being achieved by a sealed-in flexible bellows actuated by an externally-driven lead screw. Elements can thus be close-spaced without danger of flashover . . . are unaffected by dust, moisture, elevation.

Here indeed is exceptional value.

UCS-10-400X **69.50**

CONDITIONS OF SALE.

Shipments express only, add 1.60 per unit. All COD orders must be accompanied by 20% deposit. California orders add 3% state sales tax. All merchandise guaranteed new, perfect. All merchandise subject to prior sale. All prices subject to change without notice.

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AM — 90-100W

CW — 220-240W

Output

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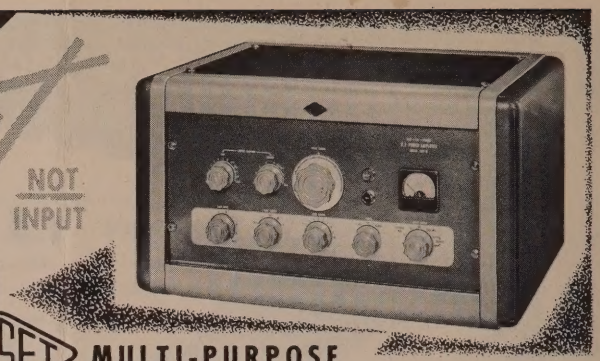

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(LINEAR, CLASS AB_2 OPERATION)

Pi network output—one knob bandswitching (including grid circuits) covering 10-11-15-20-40-80 meters with provisions for 160.

Pi network matches 50 to 300 ohm loads.

Self-contained heavy duty power supply (4-866JR's in bridge) 80 mfd output filter for excellent dynamic regulation.

Economical, low-replacement-cost tubes.(4-807's)

Excitation control . . . greatly facilitates linear amp-adjustments.

Complete metering . . . individual 807 cathodes . . . grid current. Relative RF output.

Excellent linearity on SSB or AM.

Completely free from parasitics.. or self-oscillation.

Extremely low harmonic output.

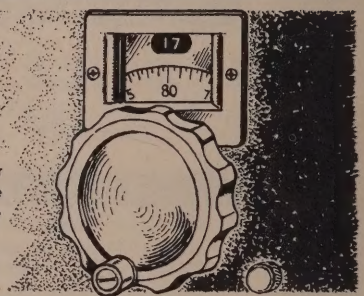
You place your station in the "Big Signal" class the minute you connect the 500W to the output of your present small exciter or low powered Transmitter. 500W is a sure investment in improved, high power performance

Though your interests may vary from time-to-time, from CW to AM phone . . . SSB today or in the future . . . 500W retains full value with its ability to comply fully with changing modes . . . or moods.

at ELMAR

E. F. JOHNSON

Counter dial



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